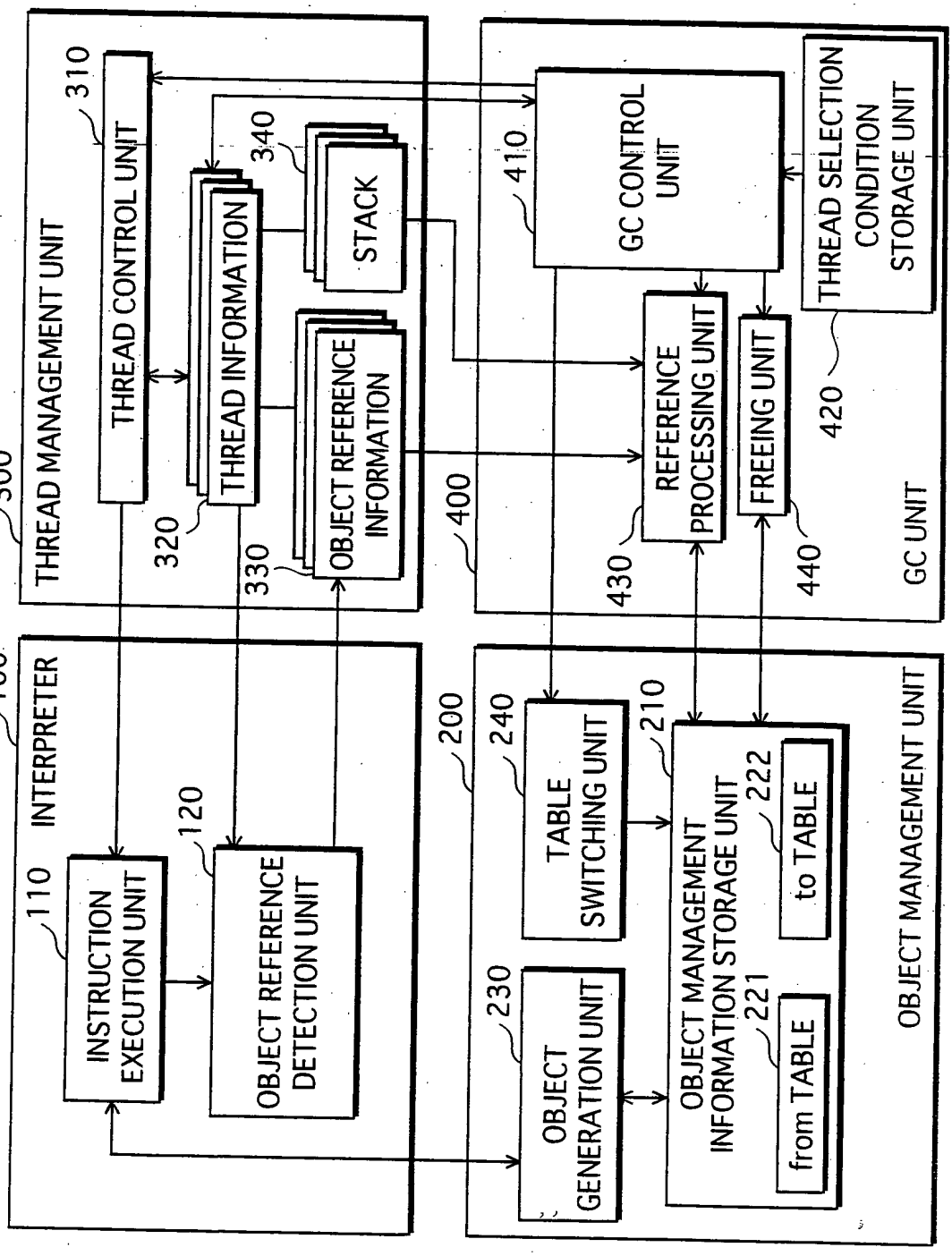
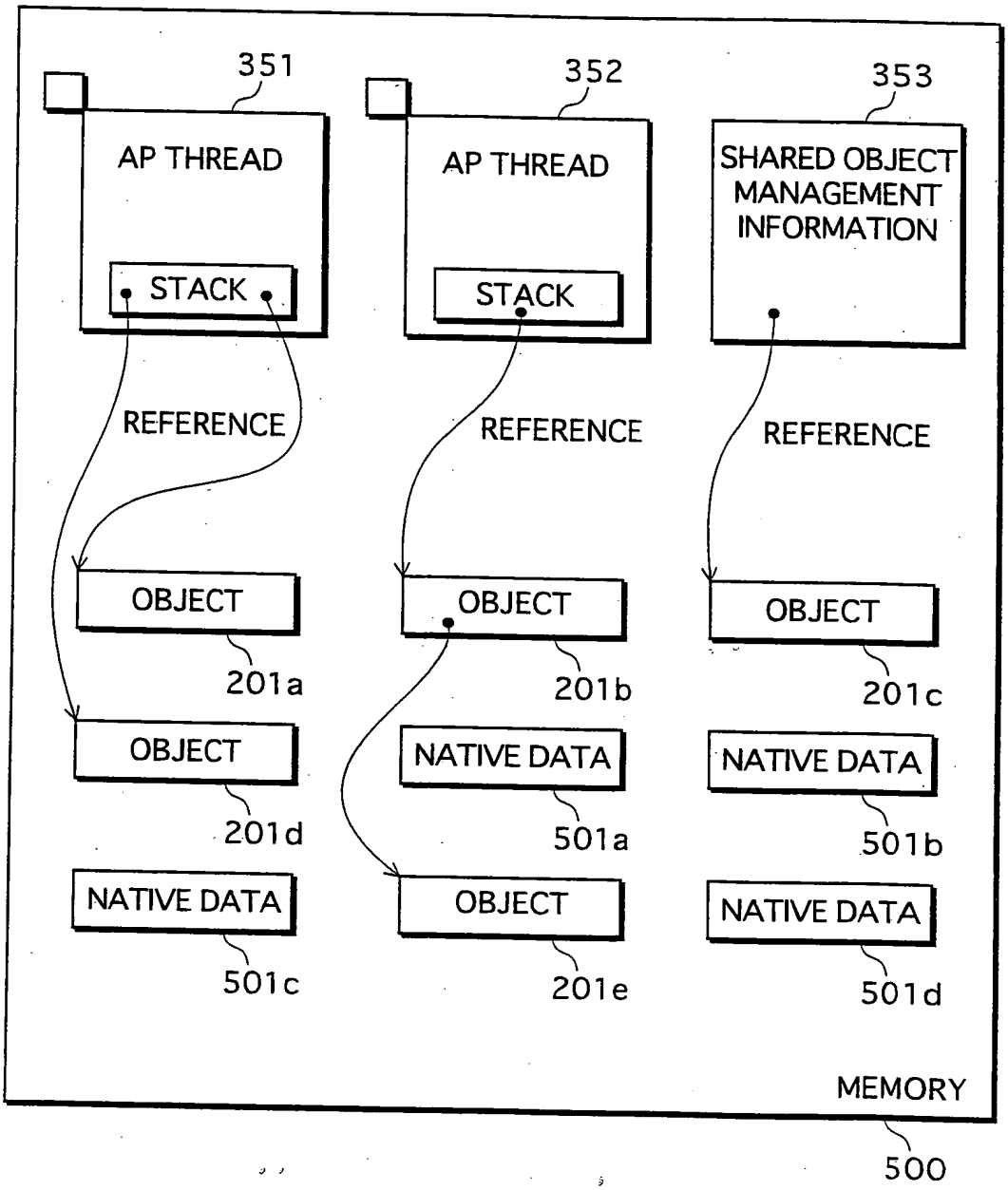

10
100
INTERPRETER
110
INSTRUCTION EXECUTION UNIT
120
OBJECT REFERENCE DETECTION UNIT
300
THREAD MANAGEMENT UNIT
310
THREAD CONTROL UNIT
320
THREAD INFORMATION
330
OBJECT REFERENCE INFORMATION
340
STACK
200
OBJECT MANAGEMENT UNIT
210
OBJECT MANAGEMENT INFORMATION STORAGE UNIT
221
from TABLE
222
to TABLE
230
OBJECT GENERATION UNIT
240
TABLE SWITCHING UNIT
400
GC UNIT
410
GC CONTROL UNIT
420
THREAD SELECTION CONDITION STORAGE UNIT
430
REFERENCE PROCESSING UNIT
440
FREEING UNIT

FIG.1

FIG.2


351
AP THREAD
STACK
352
AP THREAD
STACK
353
SHARED OBJECT MANAGEMENT INFORMATION
REFERENCE
REFERENCE
REFERENCE
OBJECT
201a
OBJECT
201b
OBJECT
201c
OBJECT
201d
NATIVE DATA
501a
NATIVE DATA
501b
NATIVE DATA
501c
OBJECT
201e
NATIVE DATA
501d
MEMORY
500

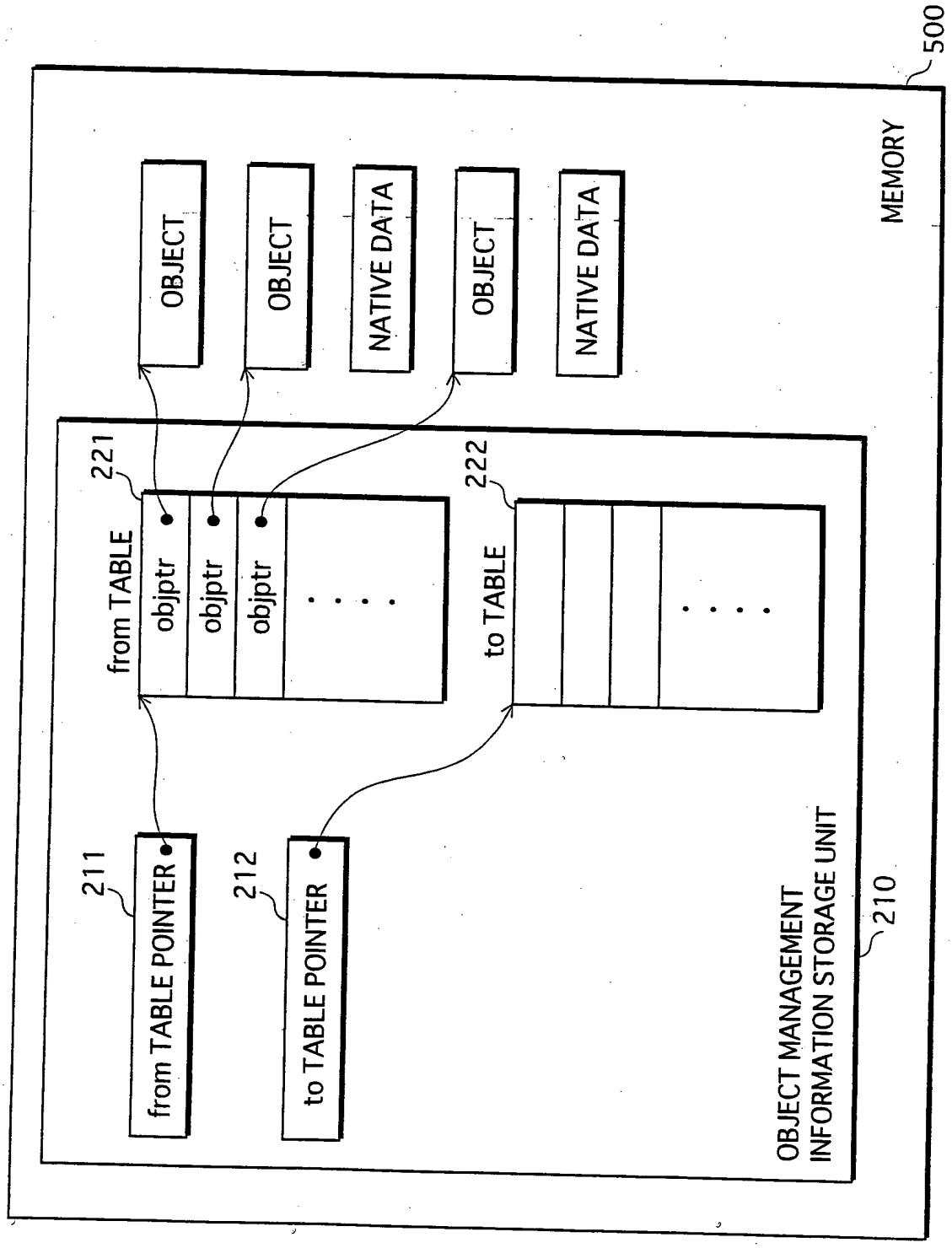

500
MEMORY
OBJECT
OBJECT
NATIVE DATA
OBJECT
NATIVE DATA
221
from TABLE
objptr
objptr
objptr
222
to TABLE
211
from TABLE POINTER
212
to TABLE POINTER
OBJECT MANAGEMENT
INFORMATION STORAGE UNIT
210

FIG.3

FIG.4A

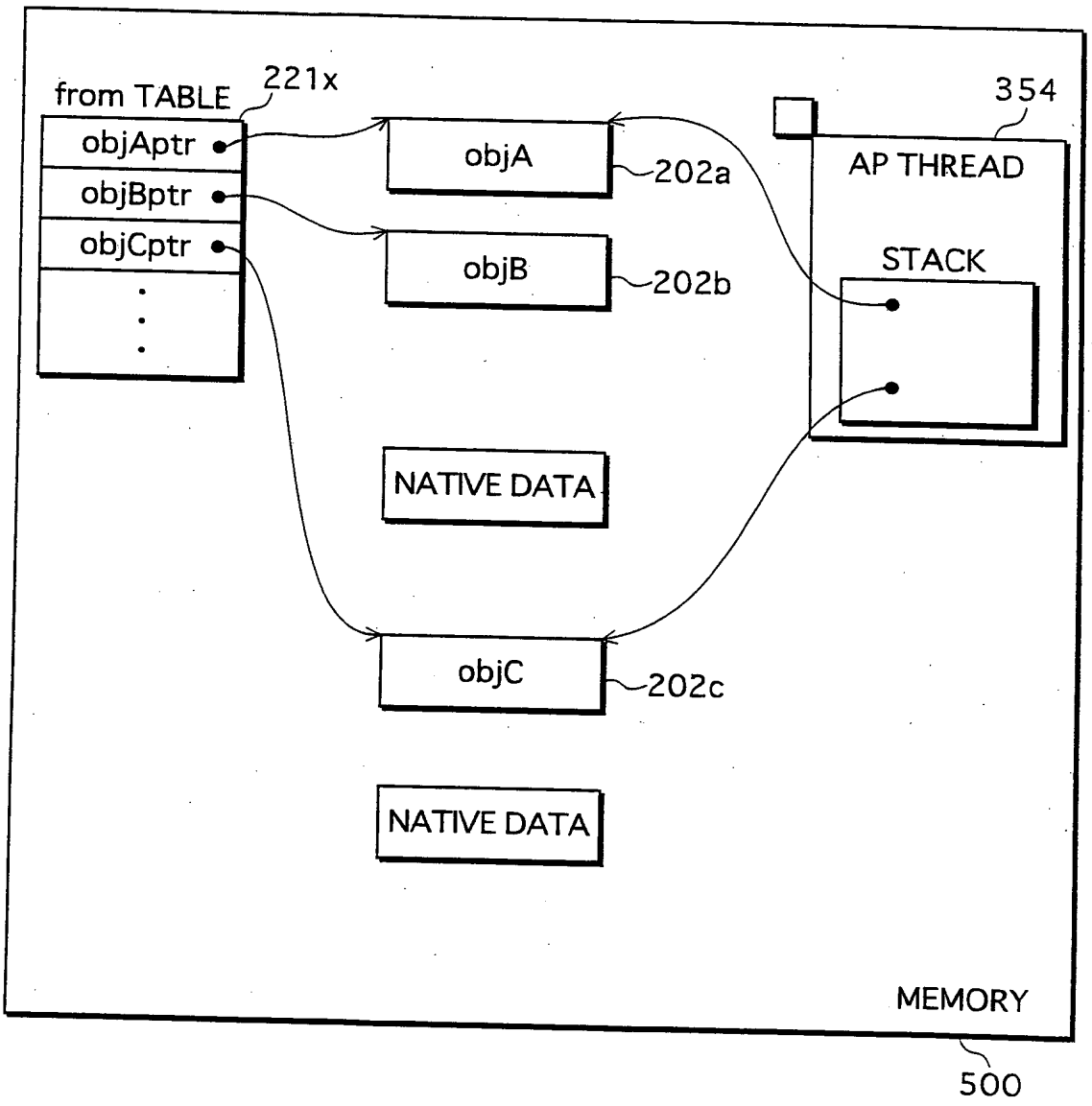

from TABLE
221x
objAptr
objBptr
objCptr
objA
202a
objB
202b
354
AP THREAD
STACK
NATIVE DATA
objC
202c
NATIVE DATA
MEMORY
500

FIG.4B

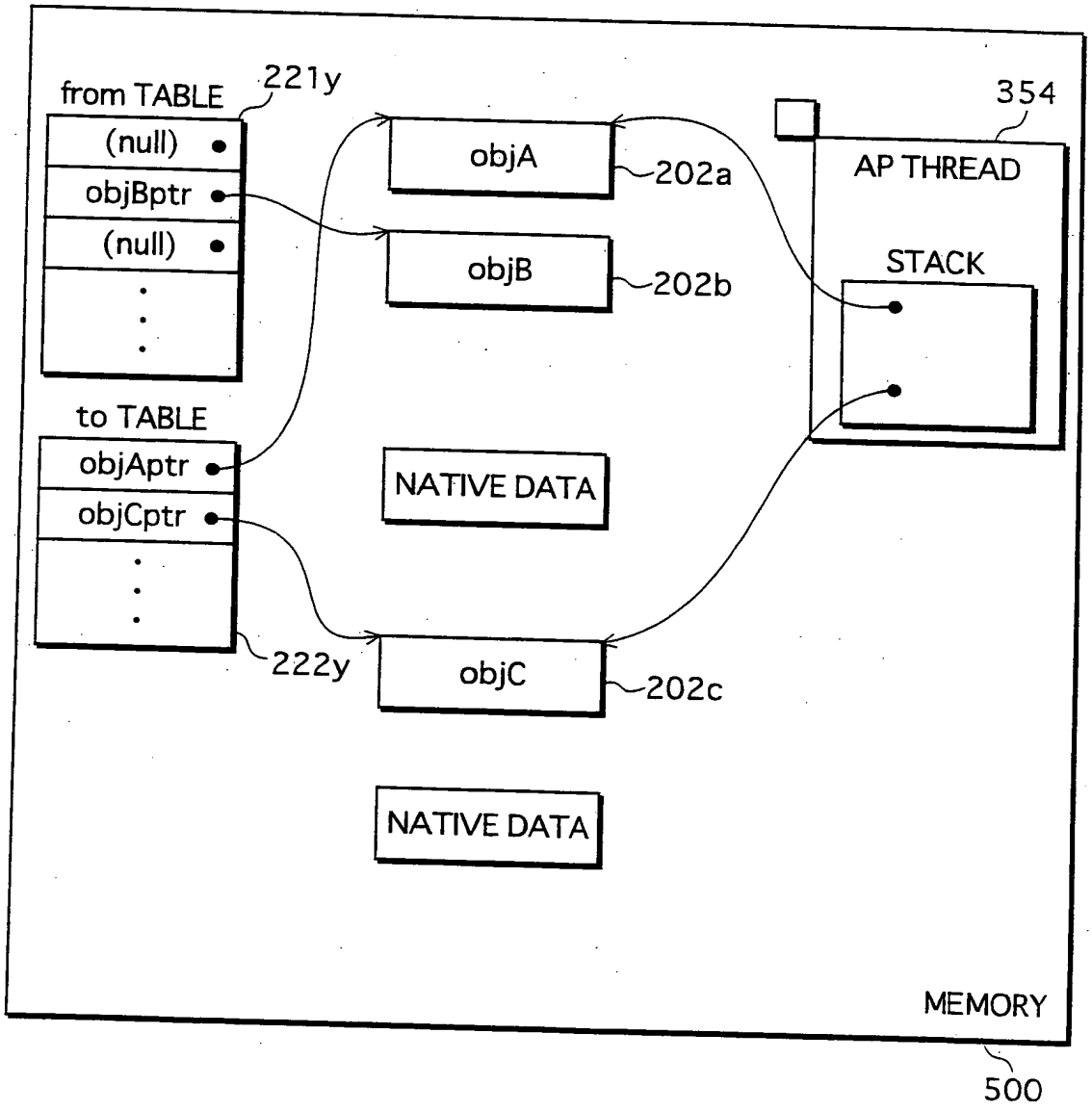

from TABLE
221y
(null)
objBptr
(null)
to TABLE
objAptr
objCptr
222y
objA
202a
objB
202b
NATIVE DATA
objC
202c
NATIVE DATA
354
AP THREAD
STACK
MEMORY
500

FIG.5

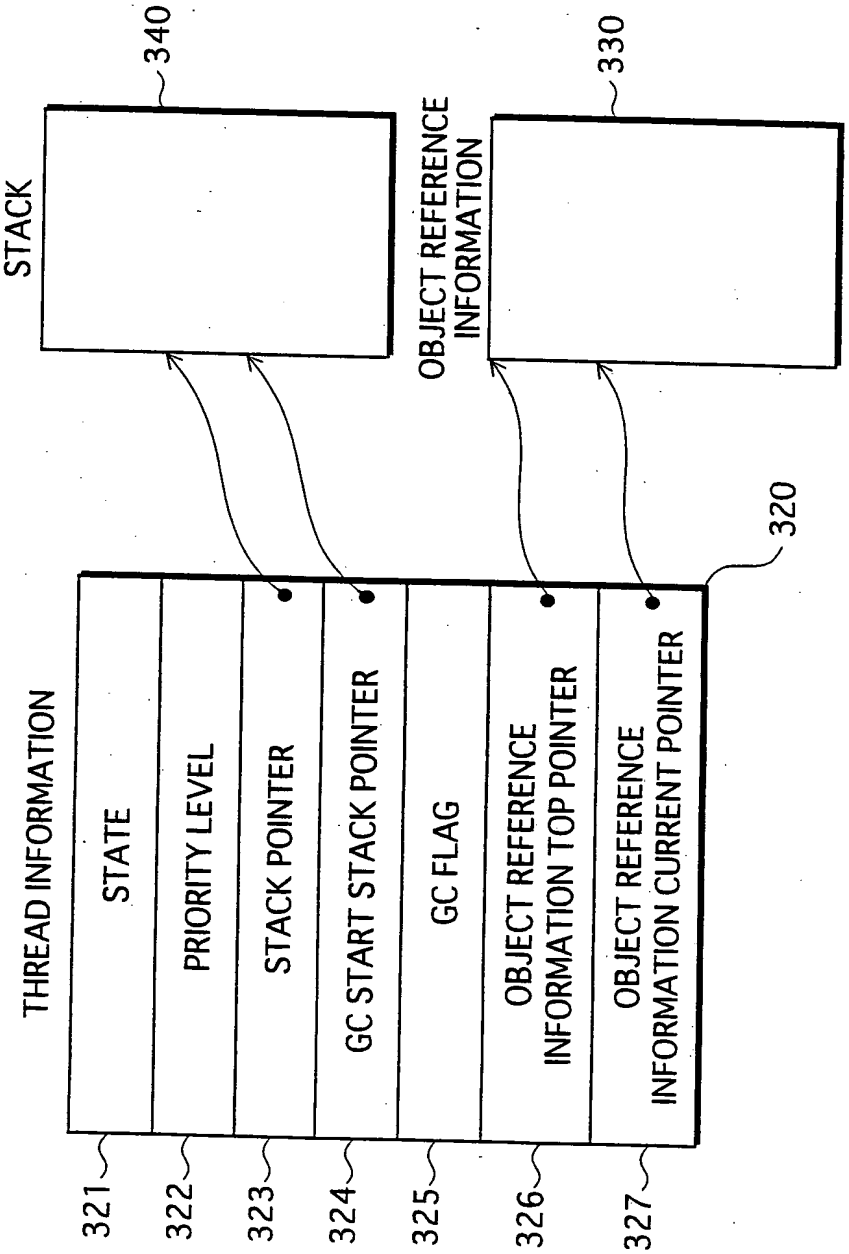

340
STACK
330
OBJECT REFERENCE INFORMATION
320
THREAD INFORMATION
STATE
PRIORITY LEVEL
STACK POINTER
GC START STACK POINTER
GC FLAG
OBJECT REFERENCE INFORMATION TOP POINTER
OBJECT REFERENCE INFORMATION CURRENT POINTER
321
322
323
324
325
326
327

FIG.6

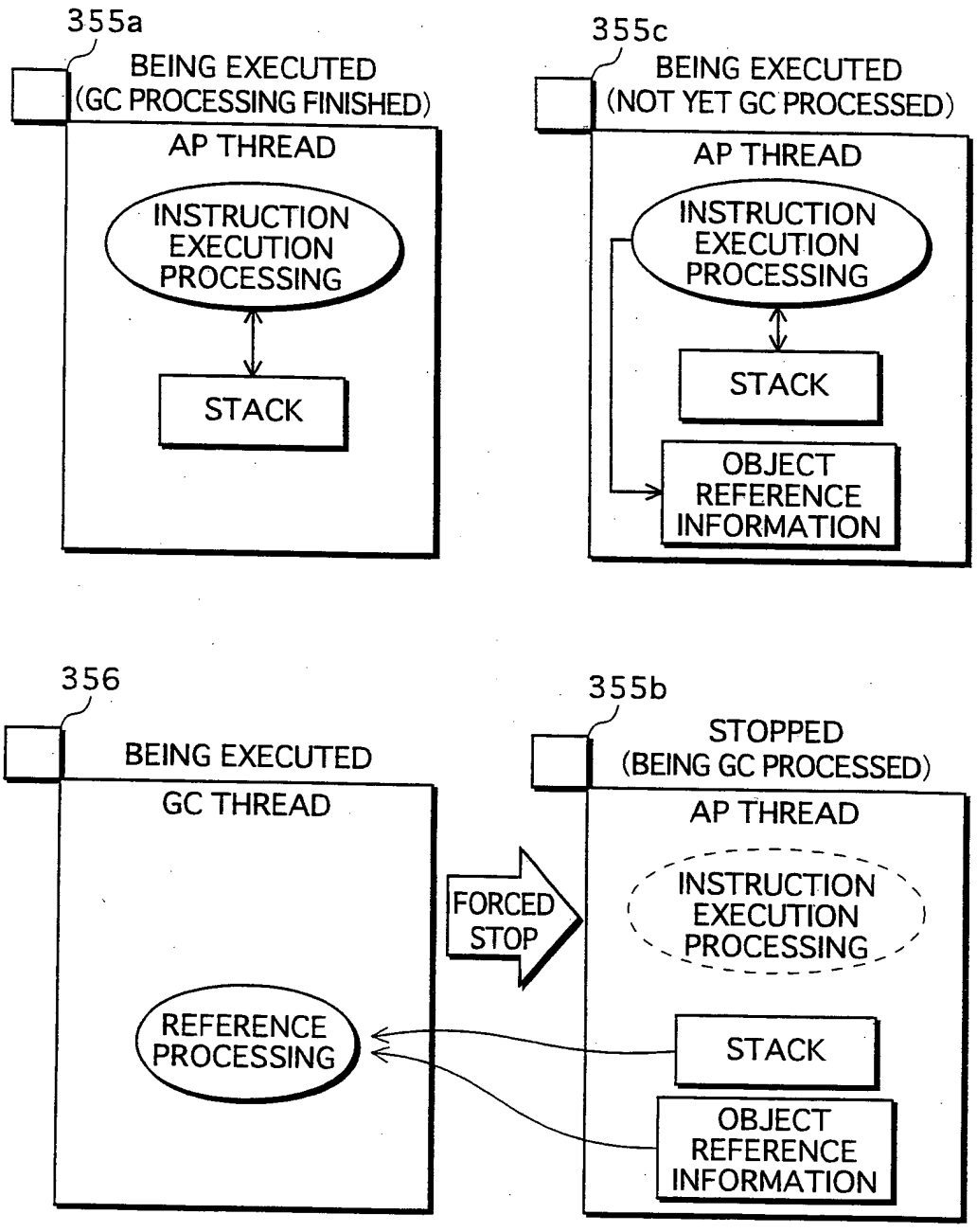

355a
BEING EXECUTED
(GC PROCESSING FINISHED)
AP THREAD
INSTRUCTION EXECUTION PROCESSING
STACK
355c
BEING EXECUTED
(NOT YET GC PROCESSED)
AP THREAD
INSTRUCTION EXECUTION PROCESSING
STACK
OBJECT REFERENCE INFORMATION
356
BEING EXECUTED
GC THREAD
REFERENCE PROCESSING
FORCED STOP
355b
STOPPED
(BEING GC PROCESSED)
AP THREAD
INSTRUCTION EXECUTION PROCESSING
STACK
OBJECT REFERENCE INFORMATION

FIG.7

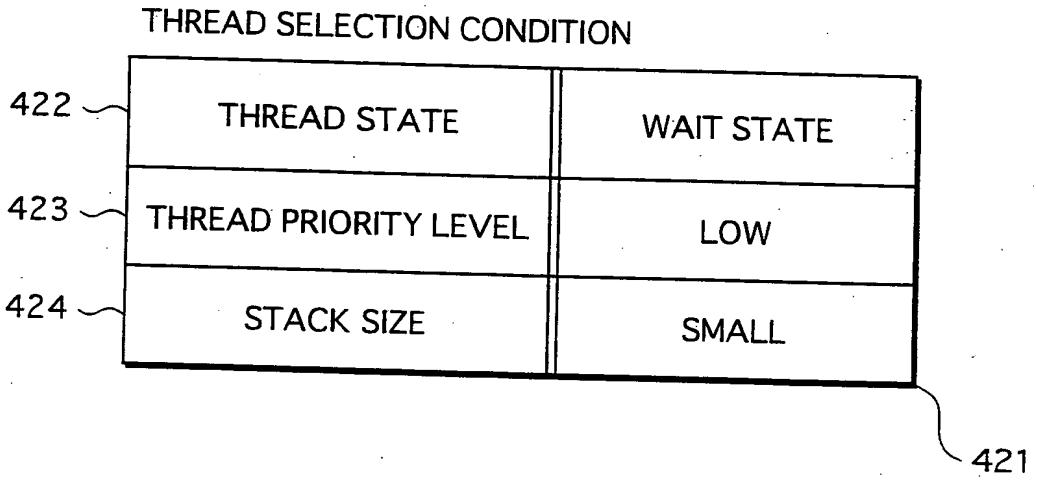

THREAD SELECTION CONDITION
422
THREAD STATE
WAIT STATE
423
THREAD PRIORITY LEVEL
LOW
424
STACK SIZE
SMALL
421

FIG.8

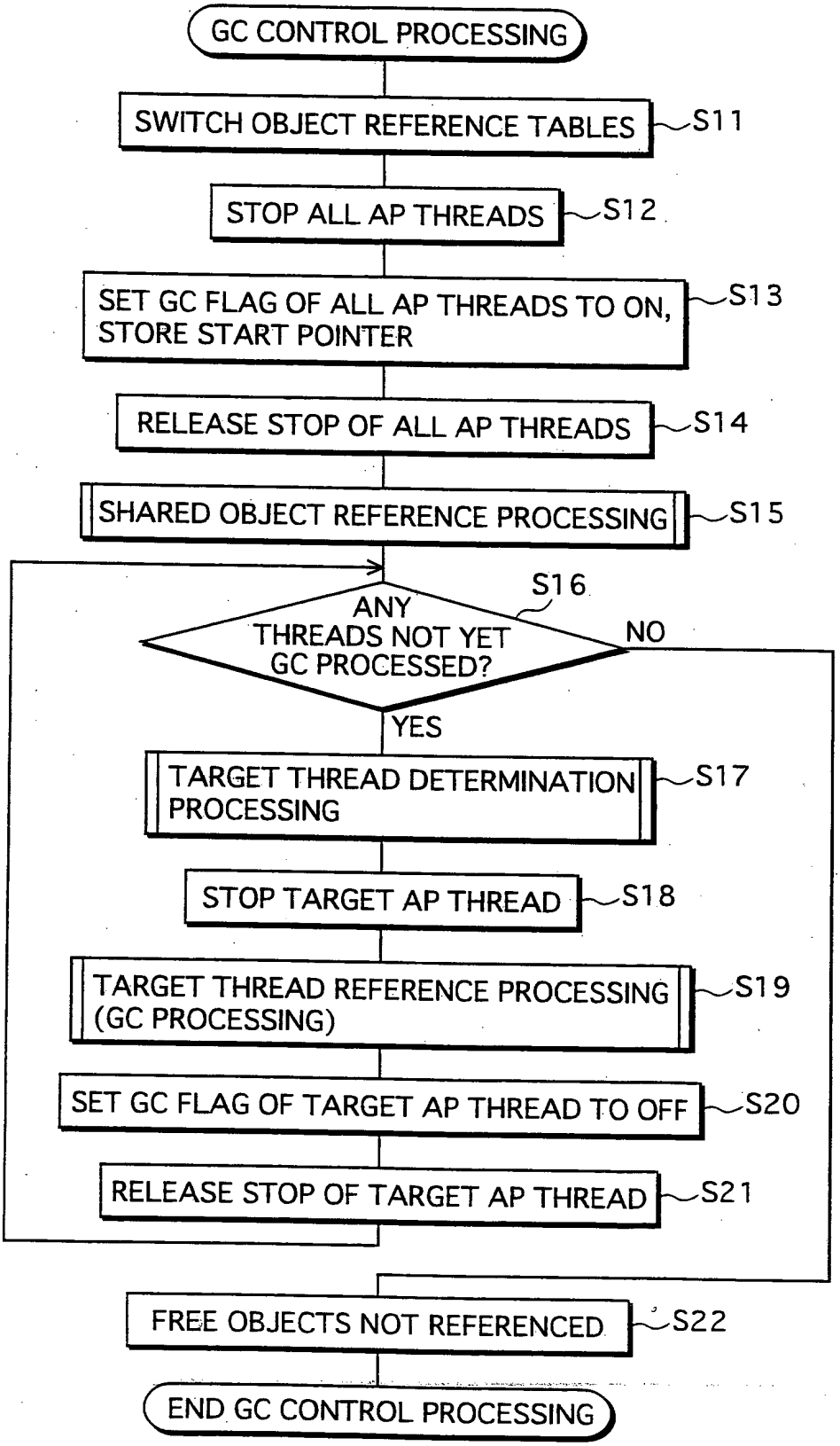

GC CONTROL PROCESSING
SWITCH OBJECT REFERENCE TABLES
S11
STOP ALL AP THREADS
S12
SET GC FLAG OF ALL AP THREADS TO ON, STORE START POINTER
S13
RELEASE STOP OF ALL AP THREADS
S14
SHARED OBJECT REFERENCE PROCESSING
S15
S16
ANY THREADS NOT YET GC PROCESSED?
NO
YES
TARGET THREAD DETERMINATION PROCESSING
S17
STOP TARGET AP THREAD
S18
TARGET THREAD REFERENCE PROCESSING (GC PROCESSING)
S19
SET GC FLAG OF TARGET AP THREAD TO OFF
S20
RELEASE STOP OF TARGET AP THREAD
S21
FREE OBJECTS NOT REFERENCED
S22
END GC CONTROL PROCESSING

FIG.9

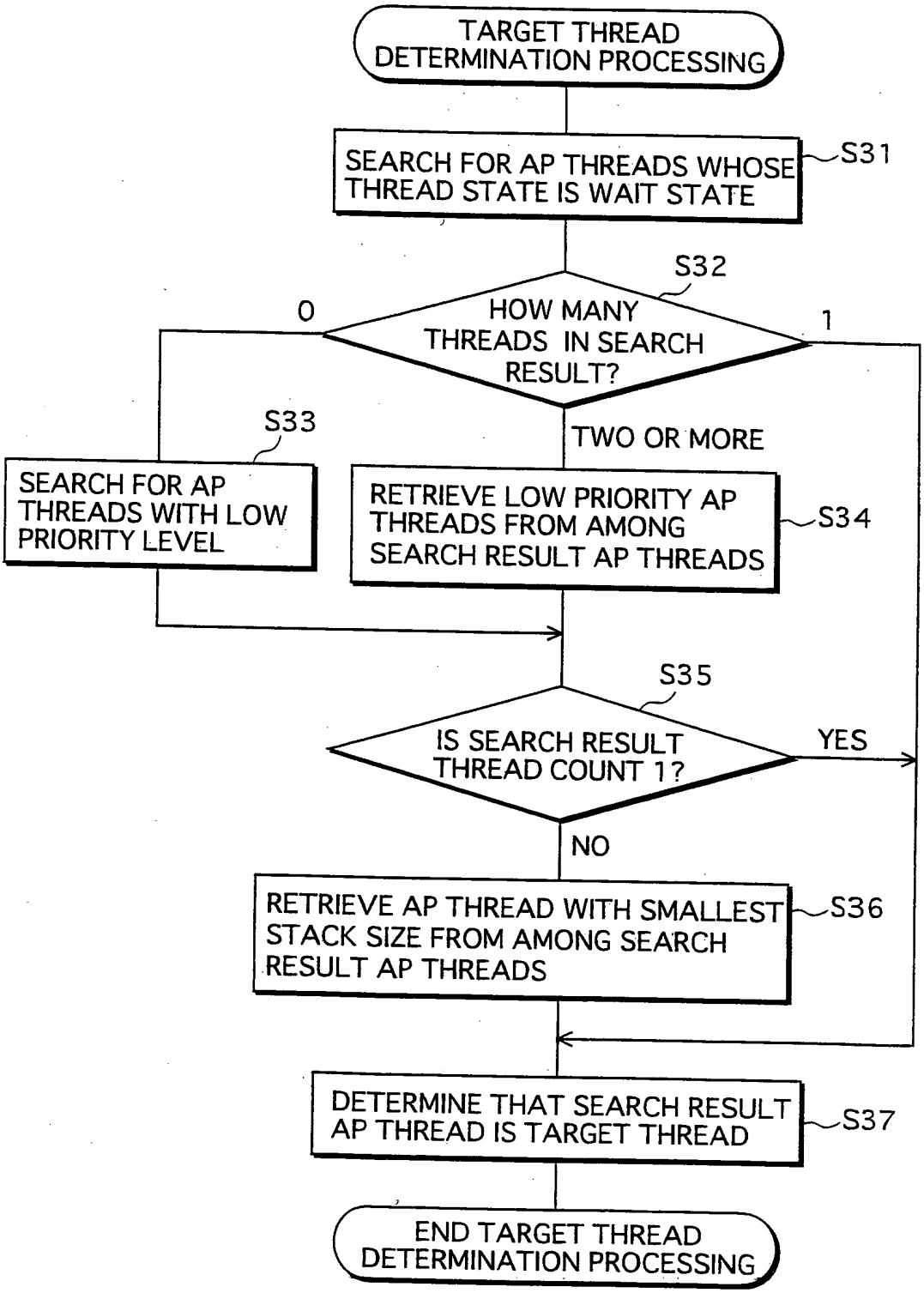

TARGET THREAD DETERMINATION PROCESSING
SEARCH FOR AP THREADS WHOSE THREAD STATE IS WAIT STATE
S31
S32
HOW MANY THREADS IN SEARCH RESULT?
0
1
TWO OR MORE
S33
SEARCH FOR AP THREADS WITH LOW PRIORITY LEVEL
RETRIEVE LOW PRIORITY AP THREADS FROM AMONG SEARCH RESULT AP THREADS
S34
S35
IS SEARCH RESULT THREAD COUNT 1?
YES
NO
RETRIEVE AP THREAD WITH SMALLEST STACK SIZE FROM AMONG SEARCH RESULT AP THREADS
S36
DETERMINE THAT SEARCH RESULT AP THREAD IS TARGET THREAD
S37
END TARGET THREAD DETERMINATION PROCESSING

FIG.10

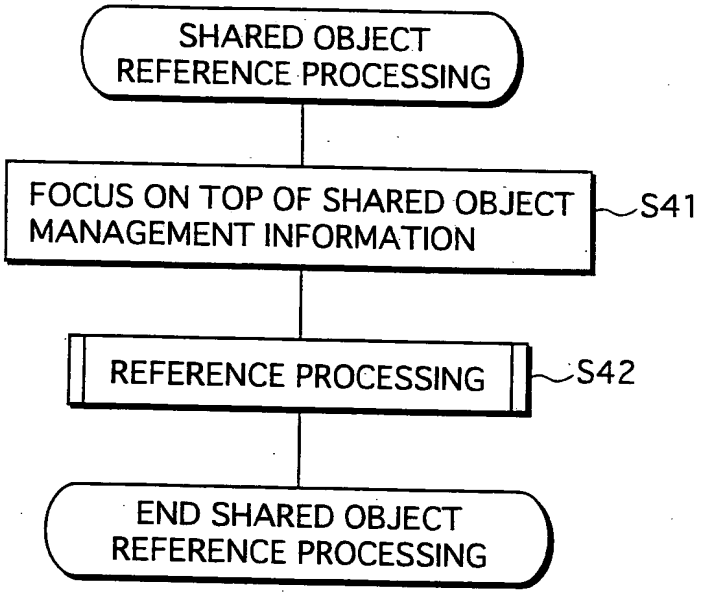

SHARED OBJECT REFERENCE PROCESSING
FOCUS ON TOP OF SHARED OBJECT MANAGEMENT INFORMATION
S41
REFERENCE PROCESSING
S42
END SHARED OBJECT REFERENCE PROCESSING

FIG.11

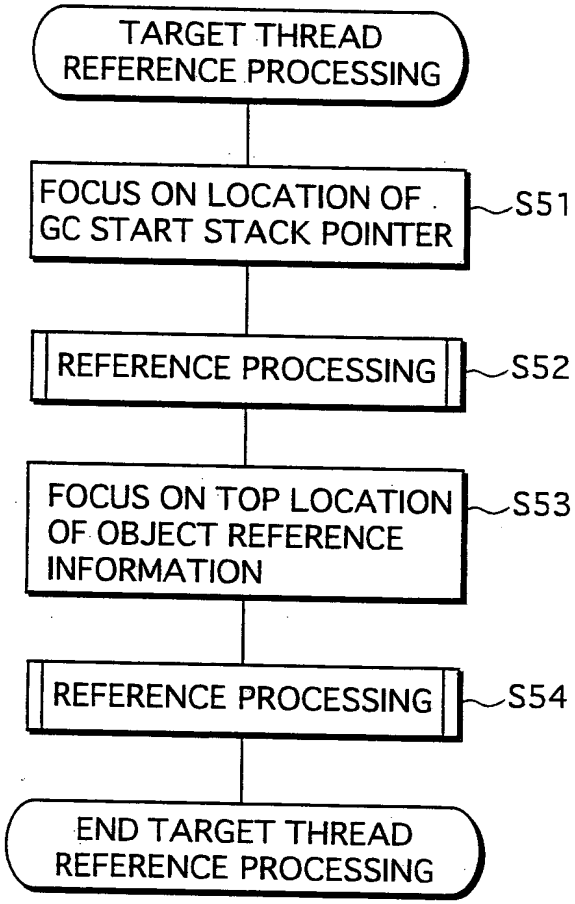

TARGET THREAD REFERENCE PROCESSING
FOCUS ON LOCATION OF GC START STACK POINTER
S51
REFERENCE PROCESSING
S52
FOCUS ON TOP LOCATION OF OBJECT REFERENCE INFORMATION
S53
REFERENCE PROCESSING
S54
END TARGET THREAD REFERENCE PROCESSING

FIG.12

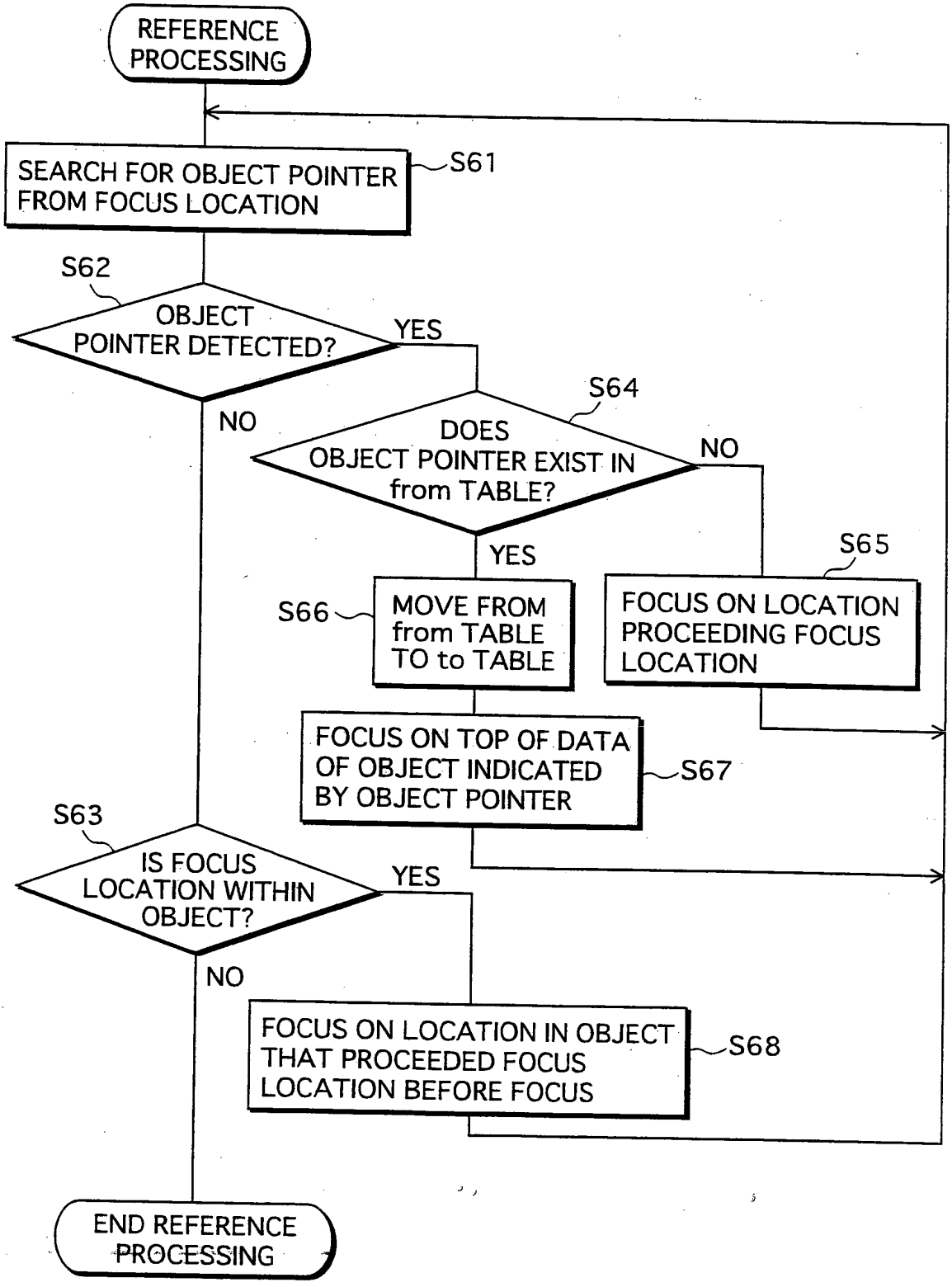

REFERENCE PROCESSING
SEARCH FOR OBJECT POINTER FROM FOCUS LOCATION
S61
S62
OBJECT POINTER DETECTED?
YES
NO
S64
DOES OBJECT POINTER EXIST IN from TABLE?
NO
YES
S65
S66
MOVE FROM from TABLE TO to TABLE
FOCUS ON LOCATION PROCEEDING FOCUS LOCATION
FOCUS ON TOP OF DATA OF OBJECT INDICATED BY OBJECT POINTER
S67
S63
IS FOCUS LOCATION WITHIN OBJECT?
YES
NO
FOCUS ON LOCATION IN OBJECT THAT PROCEEDED FOCUS LOCATION BEFORE FOCUS
S68
END REFERENCE PROCESSING

FIG.13

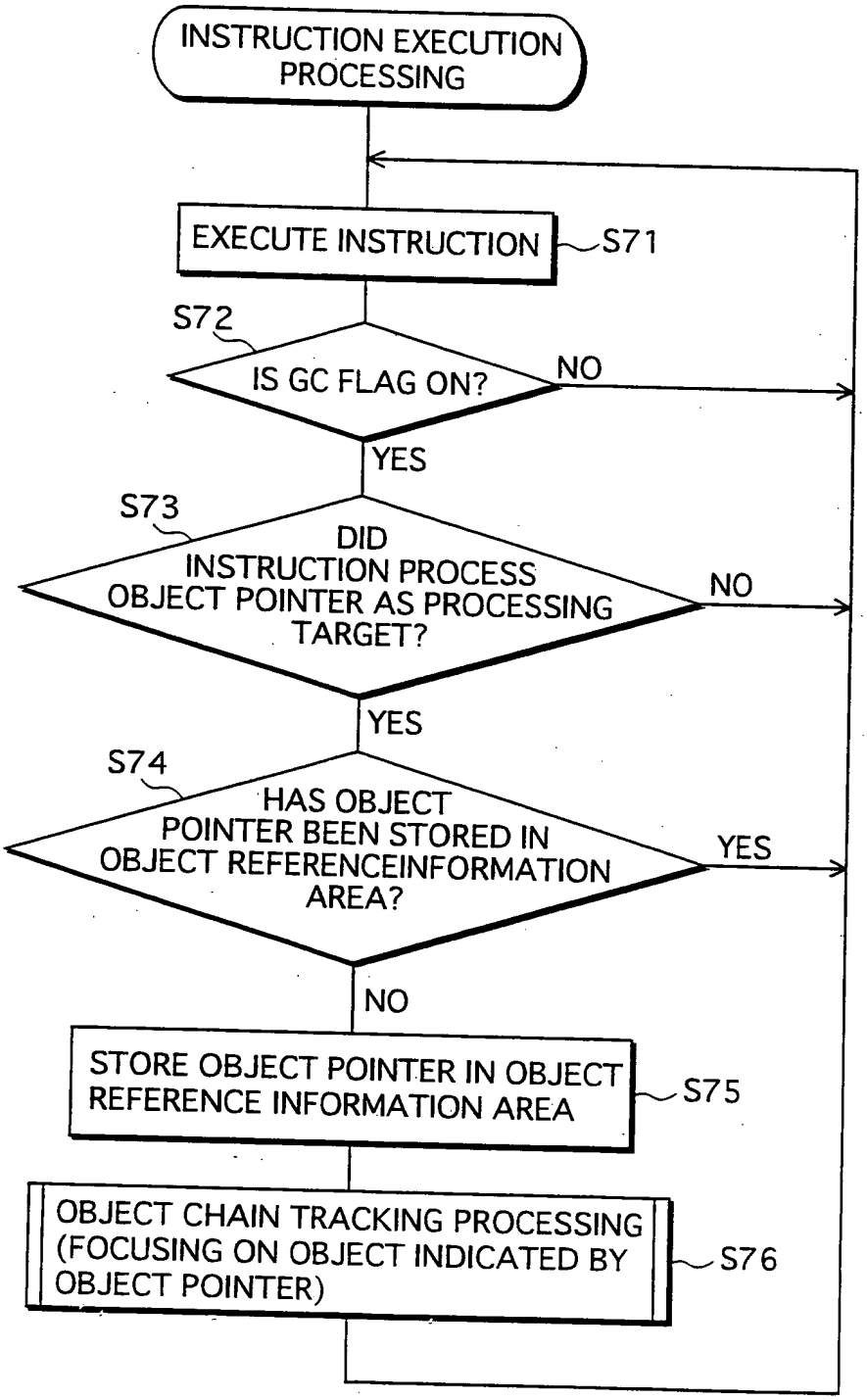
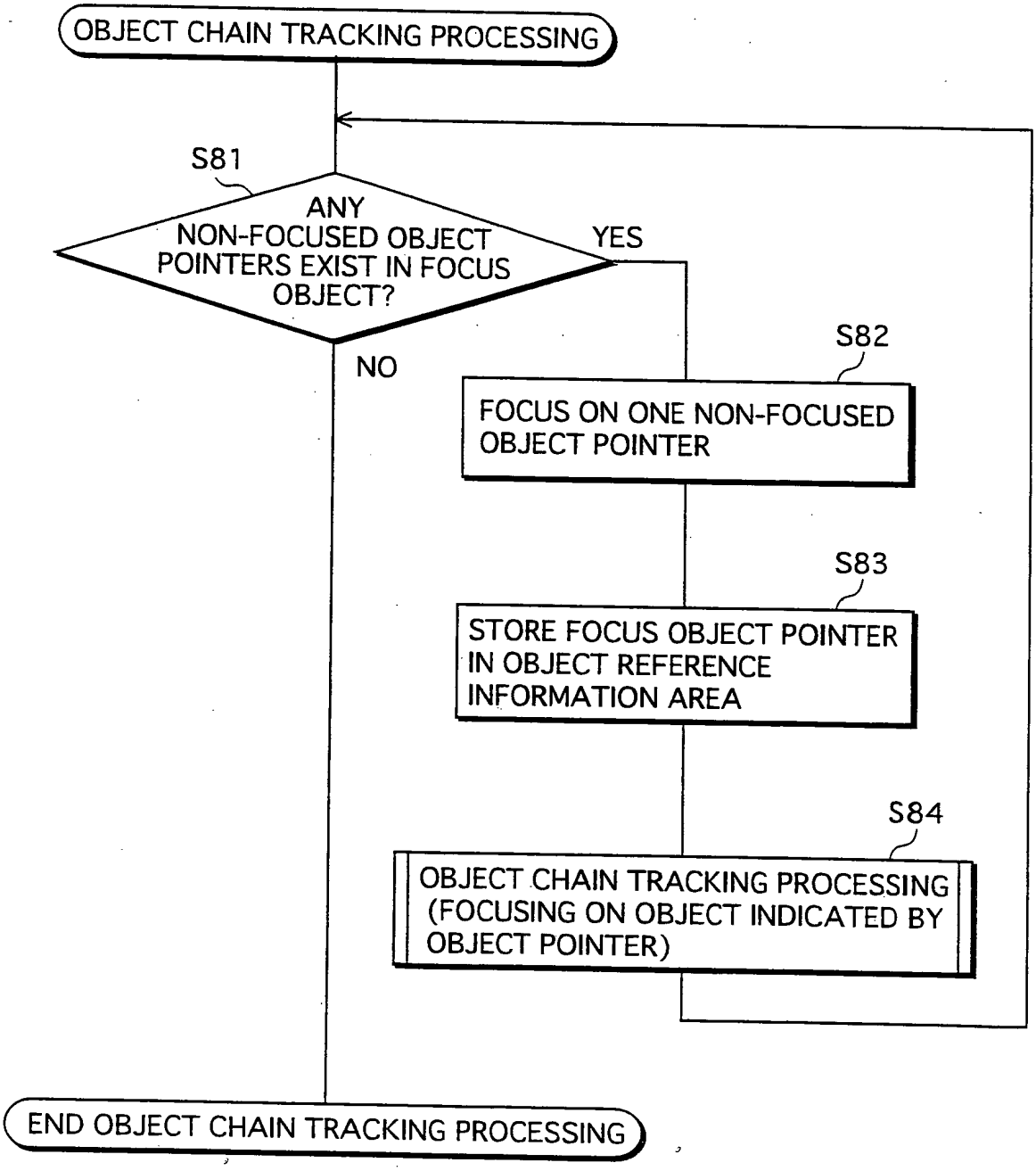

INSTRUCTION EXECUTION PROCESSING
EXECUTE INSTRUCTION
S71
S72
IS GC FLAG ON?
NO
YES
S73
DID INSTRUCTION PROCESS OBJECT POINTER AS PROCESSING TARGET?
NO
YES
S74
HAS OBJECT POINTER BEEN STORED IN OBJECT REFERENCEINFORMATION AREA?
YES
NO
STORE OBJECT POINTER IN OBJECT REFERENCE INFORMATION AREA
S75
OBJECT CHAIN TRACKING PROCESSING (FOCUSING ON OBJECT INDICATED BY OBJECT POINTER)
S76

FIG.14


OBJECT CHAIN TRACKING PROCESSING
S81
ANY NON-FOCUSED OBJECT POINTERS EXIST IN FOCUS OBJECT?
YES
NO
S82
FOCUS ON ONE NON-FOCUSED OBJECT POINTER
S83
STORE FOCUS OBJECT POINTER IN OBJECT REFERENCE INFORMATION AREA
S84
OBJECT CHAIN TRACKING PROCESSING (FOCUSING ON OBJECT INDICATED BY OBJECT POINTER)
END OBJECT CHAIN TRACKING PROCESSING

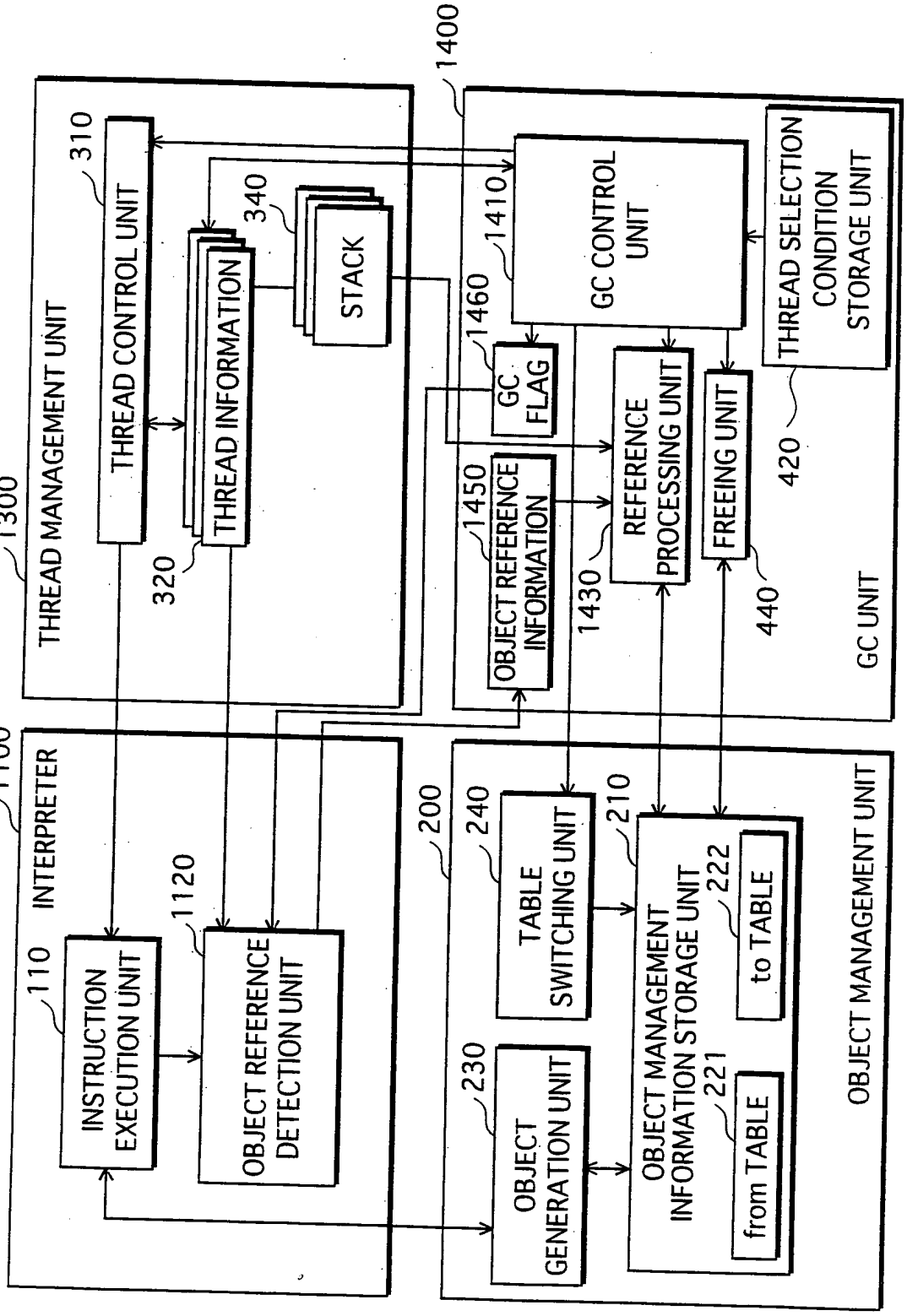

20
1400
1300
THREAD MANAGEMENT UNIT
310
THREAD CONTROL UNIT
340
STACK
THREAD INFORMATION
320
1410
GC CONTROL UNIT
1460
GC FLAG
1450
OBJECT REFERENCE INFORMATION
REFERENCE PROCESSING UNIT
1430
FREEING UNIT
440
THREAD SELECTION CONDITION STORAGE UNIT
420
GC UNIT
1100
INTERPRETER
110
INSTRUCTION EXECUTION UNIT
1120
OBJECT REFERENCE DETECTION UNIT
200
240
TABLE SWITCHING UNIT
210
OBJECT MANAGEMENT INFORMATION STORAGE UNIT
222
to TABLE
221
from TABLE
230
OBJECT GENERATION UNIT
OBJECT MANAGEMENT UNIT

FIG.15

FIG.16

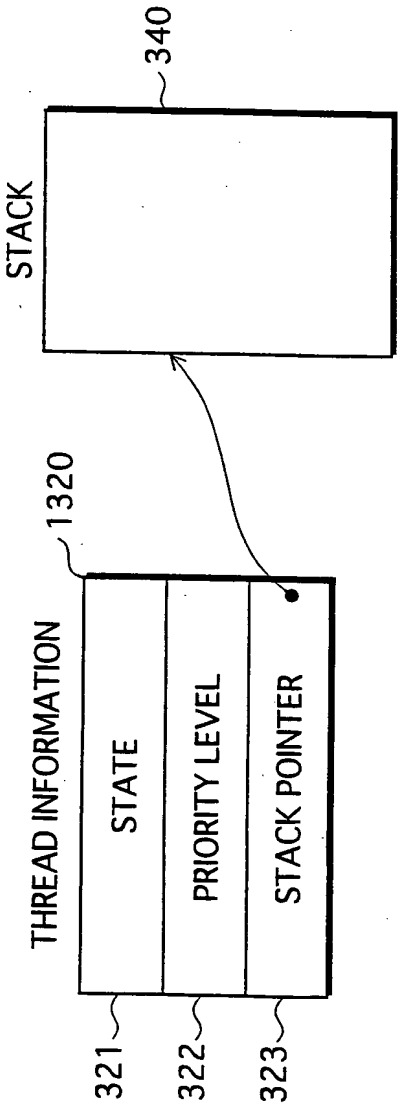

340
STACK
1320
THREAD INFORMATION
STATE
PRIORITY LEVEL
STACK POINTER
321
322
323

FIG.17

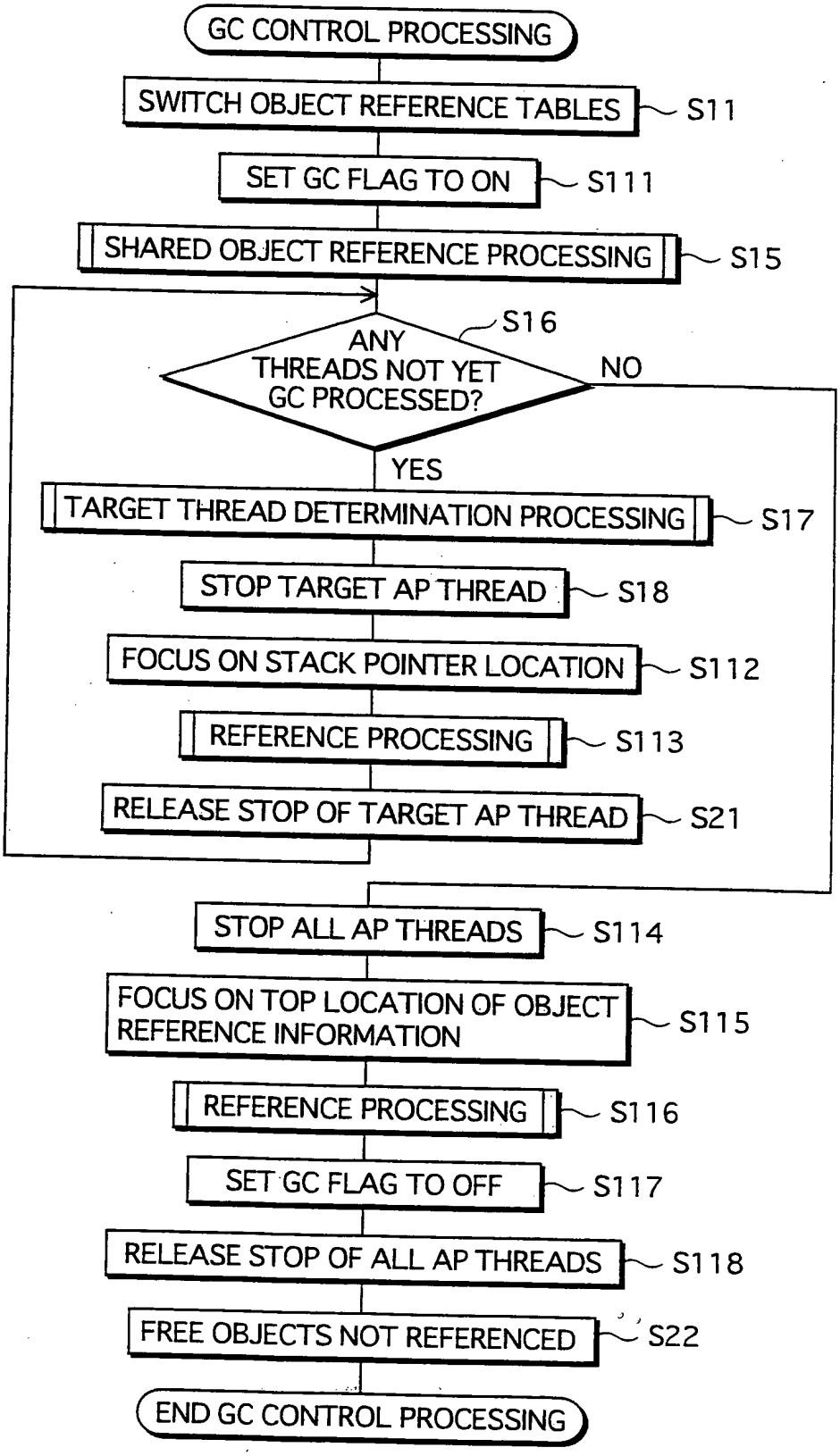

GC CONTROL PROCESSING
SWITCH OBJECT REFERENCE TABLES
S11
SET GC FLAG TO ON
S111
SHARED OBJECT REFERENCE PROCESSING
S15
S16
ANY THREADS NOT YET GC PROCESSED?
NO
YES
TARGET THREAD DETERMINATION PROCESSING
S17
STOP TARGET AP THREAD
S18
FOCUS ON STACK POINTER LOCATION
S112
REFERENCE PROCESSING
S113
RELEASE STOP OF TARGET AP THREAD
S21
STOP ALL AP THREADS
S114
FOCUS ON TOP LOCATION OF OBJECT REFERENCE INFORMATION
S115
REFERENCE PROCESSING
S116
SET GC FLAG TO OFF
S117
RELEASE STOP OF ALL AP THREADS
S118
FREE OBJECTS NOT REFERENCED
S22
END GC CONTROL PROCESSING

FIG.18

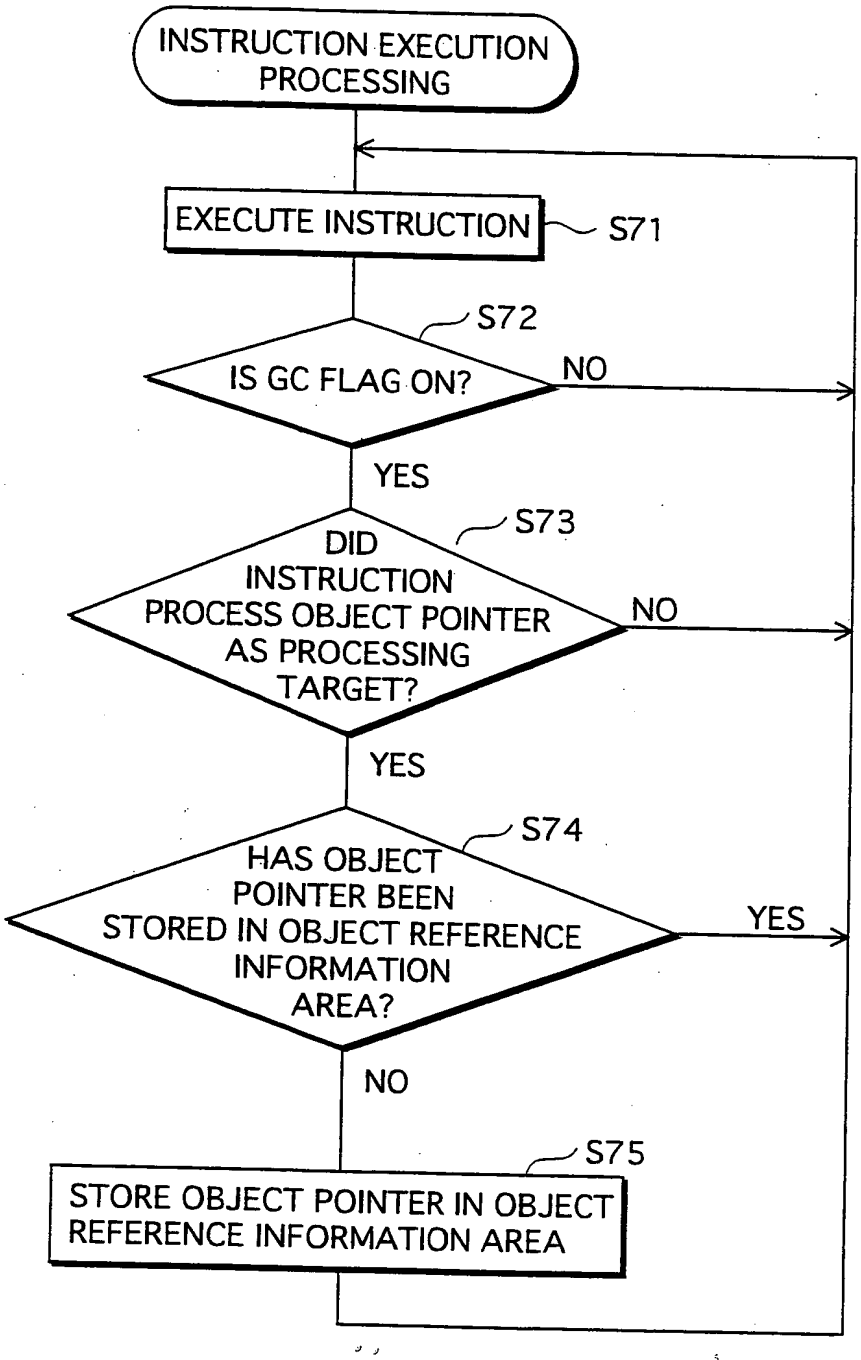
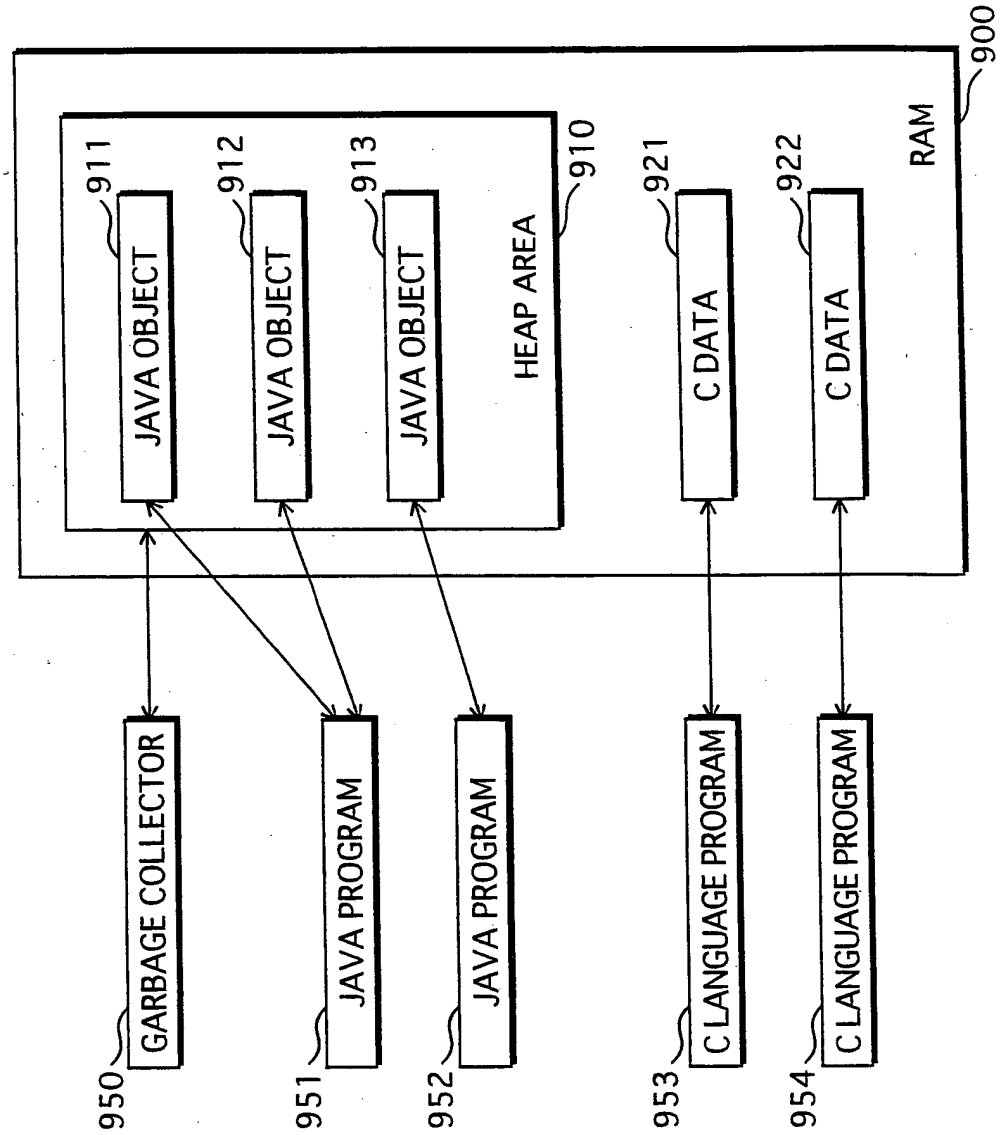

INSTRUCTION EXECUTION PROCESSING
EXECUTE INSTRUCTION
S71
S72
IS GC FLAG ON?
NO
YES
S73
DID INSTRUCTION PROCESS OBJECT POINTER AS PROCESSING TARGET?
NO
YES
S74
HAS OBJECT POINTER BEEN STORED IN OBJECT REFERENCE INFORMATION AREA?
YES
NO
S75
STORE OBJECT POINTER IN OBJECT REFERENCE INFORMATION AREA

FIG.19


900
RAM
910
HEAP AREA
911
JAVA OBJECT
912
JAVA OBJECT
913
JAVA OBJECT
921
C DATA
922
C DATA
950
GARBAGE COLLECTOR
951
JAVA PROGRAM
952
JAVA PROGRAM
953
C LANGUAGE PROGRAM
954
C LANGUAGE PROGRAM